

Calculations Using Engineering Previews

Calculation can be executed in NORMAL mode (excluding N-base) using the following 9 types of prefixes.

Prefix	Operation	Unit
K (kilo)	$\times 10^3$	10^3
M (mega)	$\times 10^6$	10^6
G (giga)	$\times 10^9$	10^9
T (tera)	$\times 10^{12}$	10^{12}
P (pico)	$\times 10^{-12}$	10^{-12}
n (nano)	$\times 10^{-9}$	10^{-9}
u (micro)	$\times 10^{-6}$	10^{-6}
f (femto)	$\times 10^{-15}$	10^{-15}

Modify Function

Decimal calculation results are internally obtained in scientific notation, with up to 14 digits in the mantissa. However, since calculation results are displayed in the form designated by the display notation and the number of decimal places indicated, the internal calculation result may differ from that shown in the display. By using the modify function ([MOD]), the internal value is converted to match that of the display, so that the displayed value can be used without change in subsequent operations.

- When using the Write/View editor, if the calculation result is displayed using fractions or irrational numbers, press ([MOD]) to convert it to decimal form first.
- The modify function can be used in NORMAL, STAT, MATRIX, or LIST modes.

Simulation Calculation (ALGB)

You have to find values consecutively using the same expression, such as plotting a curve for $2x^2 + 1$, or finding the variable values for $2x + 1 = 14$, once you enter the expression, all you have to do is to specify the value for the variable in the input field.

- Usable variables: A-F, X, M, and Y
- Simulation calculations can only be executed in NORMAL mode.
- Calculation ending instructions other than [END] cannot be used.

Performing calculations

- Press ([ON/OFF]).
- Input an expression with at least one variable.
- Press ([MOD]).
- The variable entry screen will appear. Enter a value, then press ([MOD]) to confirm. The calculation result will be displayed after you have entered a value for each variable used in the equation.
- After completing the calculation, press ([MOD]) to perform calculations using the same equation.
- Variables and numerical values stored in the memories will be displayed in the variable entry screen. If you do not want to change any values, simply press ([MOD]).
- Performing simulation calculation will cause values in memory to be overwritten with new values.

Solver Function

The solver function finds the value for x that reduces the entered expression to zero.

- The function uses Newton's method to obtain an approximation. Depending on the function (e.g. periodic) or start value, an error may occur (ERROR 02) due to there being no convergence to the solution for the equation.
- The value obtained by this function may include a margin of error. If it is larger than acceptable, recalculate the solution after changing the 'Start' and Δx values.
- Change the 'Start' value (e.g. to a negative value) or Δx value (e.g. to a smaller value).
- no calculation can be found (ERROR 02).
- more than two solutions appear to be possible (e.g. a cubic equation).
- to improve arithmetic precision.
- The calculation result is automatically stored in the X memory.
- Press ([ON/OFF]) to exit the solver function.

Performing solve function

- Press ([ON/OFF]).
- Input an equation with an x variable.
- Press ([MOD]).
- Enter a 'Start' value and press ([MOD]). The default value is '0'.
- Enter a Δx value (minute interval).
- Press ([MOD]).

Trans matrix name

mat-list name ([MAT-LS])	Returns the matrix with the columns transposed to rows and the rows transposed to columns.
mat-list ([MAT-LS])	Creates lists with elements from the list of the matrix (matA-L1, matB-L2, matC-L3, matD-L4). Mode changes from MATRIX mode to LIST mode.
matA-list ([MAT-LS])	Creates lists with elements from each list of the matrix (matA-L1, L2, L3, L4). Mode changes from MATRIX mode to LIST mode.

Notes:

- When the matrix entry screen is displayed, you cannot perform matrix calculations because the MATH menu is not available.
- If the calculation result is a matrix, it will be displayed in the matrix entry screen (note that this replaces any existing data in the buffer). To store the calculation result, first press ([MOD]) to exit the matrix entry screen. Press ([MAT-LS]) and select a memory (matA-matD) to store the newly-created matrix in.
- When the calculation results are in matrix form, pressing the [L1] or [L2] will bring you back to the original expression.

LIST CALCULATIONS

You can store and calculate up to 10 lists of up to sixteen elements each in LIST mode.

Press ([MOD]) to enter LIST mode.

Note: You can use the MATH menu in LIST mode to edit, recall, and store lists, as well as to call list-specific functions.

Entering and Storing Lists

Before performing list calculations, a list must be created. Follow the steps below to enter and store lists.

- Press ([MOD]) to enter LIST mode.
- Press ([MOD]) to bring up the list entry screen.
- Press ([MOD]) to bring up the list entry screen, along with any previously entered, loaded, or calculated list data, will be displayed.
- Define the list size (up to sixteen elements) by entering a value using the number keys and pressing ([MOD]).

List size	Element fields
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16

List entry screen (example)

Enter each element in the list by entering a value in the entry field and pressing ([MOD]).

- Each element point can display up to eight digits (the decimal point counts as one digit). If an element exceeds eight digits in length, it will be displayed in exponent notation within the list.
- A maximum of six elements can be displayed at one time. Use [L1] or [L2] to move the cursor to the list.

When you have entered a value for each element, press ([MOD]) to exit the list entry screen.

Press ([MOD]) and select a memory (L1-L4) to store the newly-created list in.

Modifying a stored list

- To load a stored list into the list entry screen, press ([MOD]), then select the memory (L1-L4) that holds the list you wish to modify.
- Replacing new data into the screen will automatically replace any data that may already exist there.
- Using the list entry screen, you can modify the values of elements in the list. Assign new values wherever necessary and press ([MOD]) after each one.
- If you wish to modify the size of a list, first press ([MOD]), then select the memory (L1-L4) that holds the list.
- When you have finished making changes, press ([MOD]) to exit the list entry screen.
- Press ([MOD]) and select a memory (matA-matD) to store the newly-created list in.

STATISTICAL CALCULATIONS

Statistical calculations can be performed in STAT mode. There are eight sub-modes within STAT mode. Press ([MODE]) then press the number key that corresponds to your choice:

- (1) [STAT 1] (SD): Single-variable statistics
- (2) $\text{[STAT 1 L1 L2 L3 L4]}$ (L1-L4): Linear regression
- (3) $\text{[STAT 2 Q1 Q2 Q3 Q4]}$ (Q1-Q4): Quadratic regression
- (4) [STAT 3 E-EXP] (E-EXP): Euler exponential regression
- (5) [STAT 4 L0 G6] (Log6): Logarithmic regression
- (6) [STAT 5 P0 E R K] (Power): Power regression
- (7) [STAT 6 I N V] (Inv): Inverse regression
- (8) [STAT 7 G-EXP] (G-EXP): General exponential regression

Statistical Calculations and Variables

The following statistics can be obtained for each statistical calculation (refer to the table below):

Single-variable statistics (STAT 1)

Statistics of \bar{x} and the value of the normal probability function.

Linear regression calculation

Statistics of \bar{x} and \bar{y} . In addition, the estimate of y for a given x (estimate y') and the estimate of x for a given y (estimate x').

Quadratic regression calculation

Statistics of \bar{x} and \bar{y} , and coefficients a , b , c in the quadratic regression formula ($y = a + bx + cx^2$). (For quadratic regression calculations, no correlation coefficient (r) can be obtained.) When there are two x values, each value will be displayed with " \pm " or " ± 2 ", and stored separately in the X and Y memories.

Euler exponential regression, logarithmic regression, power regression, inverse regression, and general exponential regression calculations

Statistics of \bar{x} and \bar{y} . In addition, the estimate of y for a given x and the estimate of x for a given y . (Since the calculator converts each formula into a linear regression formula before actual calculation takes place, it obtains all statistics, except coefficients a and b from converted data rather than entered data.)

\bar{x}	Mean of samples (x data)
σ_x	Sample standard deviation (x data)
σ_x	Population standard deviation (x data)
n	Number of samples
Σx	Sum of samples (x data)
Σx^2	Sum of squares of samples (x data)
\bar{y}	Mean of samples (y data)
σ_y	Sample standard deviation (y data)
σ_y	Population standard deviation (y data)
Σy	Sum of samples (y data)
Σy^2	Sum of squares of samples (y data)
Σxy	Sum of products of samples (x, y)
r	Correlation coefficient
a	Coefficient of regression equation
b	Coefficient of regression equation
c	Coefficient of quadratic regression equation

Use ([L1]) and ([L2]) to perform a variable calculation in STAT mode.

([MOD]) does not function in STAT mode.

Data Entry and Correction

Before entering new data, clear the memory contents ($\text{[2ND]} \text{[C]}$).

Single-entry

Data ([DATA])	Returns a list with one element as specified.
Data ([DATA]) frequency ([DATA])	To enter multiples of the same data.
Data ([DATA]) data ([DATA])	To enter multiples of the same data.
Data ([DATA]) data ([DATA]) frequency ([DATA])	To enter multiples of the same data.

Note: Up to 100 data items can be entered. With the single-variable data, a data item with frequency assignment is counted as one data item, while an item assigned with frequency is stored as a set of two data items. With the two-variable data, a set of data items with frequency assignment is counted as two data items, while a set of items assigned with frequency is stored as a set of three data items.

Using Lists in Calculations

Lists stored in memories (L1-L4) can be used in arithmetic calculations and calculations that use x^2 , x^3 , and x^4 . You can also use the following list-specific functions that are available in the MATH menu.

sortA list name	Sorts list in ascending order.
sortD list name	Sorts list in descending order.
max list name	Returns the maximum value in the list.
min list name	Returns the minimum value in the list.
fill (value, list name)	Enters the specified value for all items.
normal list name	Sequentially normalizes each item in the list.
diff list name	Returns a new list using the difference between adjacent items in the list.
avg list name, list name	Returns a list appending the specified lists.
list name, list name	Returns the minimum value in the list.
mean list name	Returns the mean value of items in the list.
median list name	Returns the median value of items in the list.
sum list name	Returns the sum of items in the list.
prod list name	Returns the multiplication of items in the list.
stdDev list name	Returns the standard deviation of the list.
var list name	Returns the variance of the list.
o_prod list name, list name	Returns the outer product of 2 lists (vectors).
l_and list name, list name	Returns the inner product of 2 lists (vectors).
abs list name	Returns the absolute value of the list (vector).
list name	Deletes matrices with list column data from each list (L1-matA, L2-matB, L3-matC, L4-matD).
matA-list	Mode changes from LIST mode to MATRIX mode.
list-matA	Creates a matrix with column data from each list (L1-matA, L2-matB, L3-matC, L4-matD). Mode changes from LIST mode to MATRIX mode.

Notes:

- When the list entry screen is displayed, you cannot perform list calculations because the MATH menu is not available.
- If the calculation result is a list, it will be displayed in the list entry screen (note that this replaces any existing data in the buffer). To store the calculation result, first press ([MOD]) to exit the list entry screen. Press ([MOD]) and select a memory (L1-L4) to store the newly-created list in.
- When the calculation results are in list form, pressing the [L1] or [L2] will bring you back to the original expression.

EQUATION SOLVERS

The results obtained by these functions may include a margin of error.

Simultaneous Linear Equations

Simultaneous linear equations with two unknowns (2-VLE) or with three unknowns (3-VLE) may be solved using the following functions:

2-VLE: ([MOD])	$\begin{matrix} a_1x + b_1y = c_1 \\ a_2x + b_2y = c_2 \end{matrix} \quad [D] = \begin{matrix} a_1 & b_1 \\ a_2 & b_2 \end{matrix}$
3-VLE: ([MOD])	$\begin{matrix} a_1x + b_1y + c_1z = d_1 \\ a_2x + b_2y + c_2z = d_2 \\ a_3x + b_3y + c_3z = d_3 \end{matrix} \quad [D] = \begin{matrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{matrix}$

If the determinant $D = 0$, an error occurs.

If the absolute value of an intermediate result or calculation result is 1×10^{10} or more, an error occurs.

Solving simultaneous linear equations

- Press ([MOD]) to enter the list entry screen.
- Enter the value for each coefficient (i.e., etc.).
- Coefficients can be entered using ordinary arithmetic operations.
- To clear the entered coefficient, press ([C]).
- Press ([MOD]) to move the cursor up or down through the coefficients. Press ([MOD]) or ([MOD]) to jump to the first or last coefficient.
- When all coefficients have been entered, press ([MOD]) to solve the equation.
- While the solution is displayed, press ([MOD]) or ([MOD]) to return to the coefficient entry display. To clear all the coefficients, press ($\text{[2ND]} \text{[C]}$).

Data correction

Correction before pressing ([MOD]) immediately after a data entry. Delete incorrect data with ([DEL]), then enter the correct data.

Correction after pressing ([MOD]):

- Use ([L1]) or ([L2]) to display the previously entered data set.
- Press ([MOD]) to display the data set in ascending (oldest first) order. To reverse the display order to descending (latest first), press the [L1] key. Press ([MOD]) or ([MOD]) to jump the cursor to the beginning or end of the data set.
- Each data set is displayed with "X", "Y", or "F".

DATA SET=4	Data set number
Frequency	Frequency
DATA SET=4	Data set number
Frequency	Frequency

- To delete a data set, display and move the cursor to an item of the data set to delete by using ([L1]) and ([MOD]), then press ([DEL]) ([C]). The data set will be deleted.
- To add a new data set, press ([MOD]) to the display of previously entered data and input the values, then press ([MOD]).

Statistical Calculation Formulas

Type	Regression formula
Linear	$y = a + bx$
Quadratic	$y = a + bx + cx^2$
Euler exponential	$y = a \cdot b^{cx}$
Logarithmic	$y = a + b \cdot \ln x$
Power	$y = a \cdot x^b$
Inverse	$y = a + \frac{b}{x}$
General exponential	$y = a \cdot b^{cx^d}$

An error will occur when:

- The absolute value of the intermediate result or calculation result is equal to or greater than 1×10^{10} .
- The denominator is zero.
- An attempt is made to take the square root of a negative number.
- No solution exists in the quadratic regression calculation.

Normal Probability Calculations

In STAT mode, the three probability density functions can be used according to the MATH menu, with a random number used as a normal distribution variable.

- Notes:
- P(0, Q), and R(Q) will always take positive values, even when $t = 0$, because these functions follow the same principle used when solving for P(0, Q).
- Values for P(0, Q), and R(Q) are given to six decimal places.
- The standardization conversion formula is as follows:
$$z = \frac{x - \bar{x}}{\sigma} \cdot \frac{1}{\sqrt{n}}$$

DRILL MODE

Math Drill: ([MODE]) [2] [0]

Math operation questions with positive integers and 0 are generated randomly. It is possible to select the number of questions and operator type.

Multiplication Table (X Table): ([MOD]) [X]

Questions from each row of the multiplication table (1 to 12) are displayed sequentially or randomly.

To exit DRILL mode, press ([MODE]) and select another mode.

Using Math Drill and X Table

- Press ([MODE]) [2] [0] for Math Drill or ([MODE]) [X] for X Table.
- Math Drill: Use ([L1]) and ([L2]) to select the number of questions (5, 10, or 100).
- X Table: Use ([L1]) and ([L2]) to select a row in the multiplication table (1 to 12).
- Math Drill: Use ([L1]) and ([L2]) to select the operator type for questions ($+$, $-$, \times , or \div).
- Math Drill: Use ([L1]) and ([L2]) to select the order type ('Serial' or 'Random').
- Press ([MOD]) to start.
- When using Math Drill or X Table (random order only), questions are randomly selected and will not repeat except by chance.

Quadratic and Cubic Equations

Quadratic ($ax^2 + bx + c = 0$) or cubic ($ax^3 + bx^2 + cx + d = 0$) equations may be solved using the following functions.

- Quadratic equation solver: ([MODE]) [2] [0]
- Cubic equation solver: ([MODE]) [2] [0]

Solving quadratic and cubic equations

Press ([MODE]) [2] [0] or ([MODE]) [2] [0]

Coefficient for each equation must be entered in the same manner as those for simultaneous linear equations.

ERRORS AND CALCULATION RANGES

An error will occur if an operation exceeds the calculation ranges, or if a mathematically illegal operation is attempted. When an error occurs, pressing ([ON/OFF]) or ([MOD]) automatically moves the cursor back to the place in the equation where the error occurred. Exit the equation or press ([ON/OFF]) or ([MOD]) to clear the equation.

Error codes and error types

- ERROR 01: Syntax error
- An attempt was made to perform an invalid operation.
- ERROR 02: Calculation error
- The absolute value of an intermediate or final calculation result equals or exceeds 10^{10} .
- An error occurred because a calculation result was equal to zero (or an intermediate calculation resulted in zero).
- The calculation ranges were exceeded while performing calculations.
- ERROR 03: Nesting error
- The available number of buffers was exceeded. (There are 10 buffers* for numeric values and 64 buffers for calculation instructions).
- 5 buffers for CPLX mode, and 1 buffer for matrix/list data.
- ERROR 04: Data over error
- Data items exceeded 100 in STAT mode.
- ERROR 07: Definition error
- Matrix/List definition error or the attempted entering of an invalid value.
- ERROR 08: DIM mismatched error
- Matrix/List dimensions inconsistent while calculating.
- ERROR 09: Invalid DIM error
- Size of matrix/dim exceeds calculation range.
- ERROR 10: Undefined error
- Undefined matrix/List used in calculation.

Alert Messages

- Cannot delete
- The selected item cannot be deleted by pressing ([BS]) or ([DEL]) ([C]) in the Write/View editor.
- In this example, delete the exponent before attempting to delete the parentheses.
- Cannot call
- The function or operation stored in definable memory (D1 to D4) cannot be called.
- Ex. An attempt was made to recall a statistical variable from within NORMAL mode.
- Expressions stored in formula memories (F1 to F4) cannot be called.
- Buffer full
- The equation (including any calculation ending instructions) exceeds its maximum input buffer (150 characters in the Write/View editor or 161 characters in the Line editor). An equation may not exceed its maximum input buffer.

- Enter the answer. If you make a mistake, press ([ON/OFF]) or ([BS]) to clear any answer in memory, and enter your answer again.
- Press ([MOD]).
- If the answer is correct, " \checkmark " appears and the next question is displayed.
- If the answer is wrong, " \times " appears and the same question is displayed. This will be counted as an incorrect answer.
- If you press ([ON/OFF]) without entering an answer, the correct answer is displayed and then the next question is displayed. This will be counted as an incorrect answer.
- Continue answering the series of questions by entering the answer and pressing ([MOD]).
- After you finish, press ([MOD]) and the number and percentage of correct answers are displayed.
- Press ([MOD]) to return to the initial screen for your current drill.

Math Drill sample

0 1/25	Current questions
13x 9=	Question
0 8/25	Operator type
13x 9=	See step 6 above.
13x 9=	Number of questions
13x 9=	Operator type
13x 9=	Percentage correct
13x 9=	Correct answers

X Table sample

X Table	12
7x 1=	Question
7x 1=	See step 6 above.
7x 1=	Number of questions
7x 1=	Operator type
7x 1=	Percentage correct
7x 1=	Correct answers

Ranges of Math Drill Questions

- The range of questions for each operator type is as follows.
- Addition operator: $0 + 0$ to $20 + 20$
- Subtraction operator: $0 - 0$ to $20 - 20$; answers are positive integers and 0.
- Multiplication operator: 1×0 or 0×1 to 12×12
- Division operator: $0 \div 1$ to $144 \div 12$; answers are positive integers from 1 to 12 and 0, dividends of up to 144, and divisors of up to 12.
- Mixed operators: Questions within all the above ranges are displayed.

COMPLEX NUMBER CALCULATIONS

To carry out addition, subtraction, multiplication, and division using complex numbers, press ([MODE]) [2] to select CPLX mode. Results of complex number calculations are expressed using two systems:

- ([MOD]) [2] : Rectangular coordinate system (The XY symbol appears.)
- ([MOD]) [2] : Polar coordinate system (The PR symbol appears.)

Complex Number Entry

- Rectangular coordinates
- x -coordinate ([X]) y -coordinate ([Y])
- x -coordinate ([X]) y -coordinate ([Y])
- Polar coordinates
- r ([R]) θ ([A])
- On selecting another mode, the imaginary part of any complex number stored in the independent memory (M) and the last answer memory (ANS) will be cleared.

Calculation Ranges

- Within the ranges specified, this calculator is accurate to ± 1 of the 10th digit of the mantissa. However, a calculation error due to accumulation of continuous calculations due to accumulation of each calculation error. This is the same for y^x , x^y , $n! \cdot e$, \ln , $\text{Matrix/List calculations}$, etc., where continuous calculations are performed internally.)
- Additionally, a calculation error will accumulate and become larger in the vicinity of inflection points and singular points of functions.
- Calculation ranges
- $\pm 10^9$ to $\pm 9.99999999 \times 10^{10}$ and 0.
- If the absolute value of a calculation is less than 10^{-10} , the value is considered to be 0 in calculations and in the display.
- Display of results using $\sqrt{\quad}$
- Calculation results may be displayed using $\sqrt{\quad}$ when all of the following conditions are met:
- When intermediate and final calculation results are displayed in the following form:
$$\frac{a \pm b}{c} \pm \frac{d \pm e}{f}$$
- When each coefficient falls into the following ranges:
 $1 \leq a < 100$; $1 < b < 1000$; $0 \leq c < 100$;
 $1 \leq d < 1000$; $1 \leq e < 100$; $1 \leq f < 100$
- When the number of terms in the intermediate and final calculation result is one or two.
- Note: The result of two fractional terms that include $\sqrt{\quad}$ will be reduced to a common denominator.

BATTERY REPLACEMENT

Notes on Battery Replacement

Improper handling of batteries can cause electrolyte leakage or explosion. Be sure to observe the following handling rules:

- Make sure the new battery is the correct type.
- When installing, orient the battery properly as indicated in the calculator.
- The battery is factory-installed below the shipment, and may be exhausted before it reaches the service life stated in the specifications.

Notes